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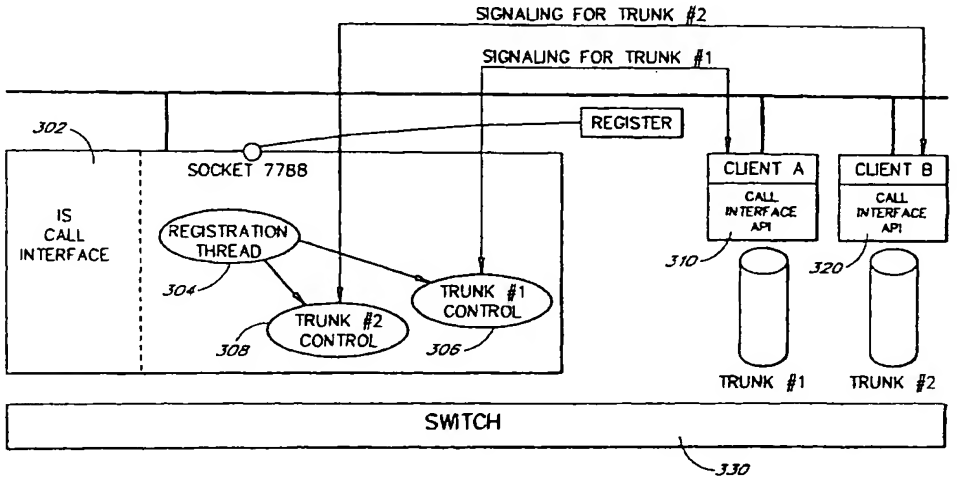
(54) Title: METHOD AND SYSTEM FOR CALL PROCESSING USING AN SS7 GATEWAY




(57) Abstract: The present invention provides systems and methods for interconnecting managing messaging between an signaling system 7 (SS7) public switched telephone network (PSTN), an SS7 gateway, and one or more interactive voice response (IVR) systems used in computer telephony integration (CTI). The SS7 gateway receives the SS7 signaling from a PSTN switch over a first trunk, while the voice data is transmitted from the PSTN switch to one or more IVR systems over one or more TCP voice trunks. The SS7 gateway communicates with the IVR systems over a local area network, wide area network or the Internet using an SS7 gateway-to-IVR data signaling format.

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# METHOD AND SYSTEM FOR CALL PROCESSING USING AN SS7 GATEWAY

## Background of the Invention

### Field of the Invention

The present invention relates to telephony gateways, and in particular, to methods and systems for interfacing a telephone network to a call processing system utilizing a Signaling System 7 (SS7) gateway.

### Description of the Related Art

As is known well, ITU standard Signal System 7 (SS7) is an international standard for network-to-network signaling. An SS7 network is used to switch information messages and to set up, manage, and release calls. The SS7 standard utilizes a common channel, out-of-band signaling method in the Public Switched Telephone Network (PSTN). The signaling planes and voice or data circuit planes are logically separated, and the signaling information is carried on a common signaling plane. SS7 signaling is used in conjunction with the PSTN to handle call establishment, routing operations, information exchanges, billing and provide support for Intelligent Network services.

The SS7 network includes network nodes that act as signaling points or elements. The SS7 network includes three signaling element types, a Service Switching Point (SSP), a Signal Transfer Point (STP), and a Service Control Point (SCP). The signaling elements are also referred to as signaling points, endpoints, exchanges, or switches. An SSP is typically an end office or tandem switch used to connect voice or data circuits and which performs the signaling functions needed to originate or terminate calls. An STP is used to route the signaling messages in an SS7 network. An SCP provides database access to databases storing routing information and tables.

Each SS7 signaling element has an associated numerical identification code, referred to as a point code. These point codes are included in the source and destination point address fields in signaling messages. The signaling elements are connected by several different link types, including A-links, B-links, C-links, D-links, E-links and F-links. Conventionally, in a common channel signaling system, signaling endpoints (SEP) are connected by a data link so that a trunk signal transmitted in accordance with a predetermined protocol is used to control communication lines. An endpoint is a data source or sink. Trunk circuit-connected gateways and switches are physical endpoints, and announcements stored in audio devices are logical endpoints. Endpoints are identified by the domain name of the entity where the endpoint exists and the local name specifying the individual endpoint, such as, in the case of trunk circuit, by a trunk group and circuit number. For example, the endpoint may be identified as follows: domain name/interface/circuit number.

Typically, businesses have enterprise telephony systems that are connected to the PSTN via an analog line, an ATM network, or other technique. Enterprise telephony systems provide many call features of interest to businesses, such as voice mail, three-way calling, hold, and others. Many enterprise telephony systems support computer telephony integration (CTI) which includes links allowing third party applications to control at least a portion

of the enterprise telephony system's operations. Thus, for example CTI may be used to provide links to systems which provide enhanced voice or fax communications, or call control functions. One example of a CTI service is an interactive voice response (IVR) system which provides voice mail service, and/or allows a subscriber to listen to e-mail via voice reproduction of the e-mail, allows a subscriber to transmit voice messages via e-mail, and provides Internet phone service, also termed Voice over IP (VoIP).

Conventionally, both voice and SS7 signaling are transmitted over the same trunk to the SS7 gateway. Disadvantageously, a conventional SS7 gateway, used to interface the PSTN to the enterprise telephony system, is implemented by including both an SS7 signaling link and an IVR system in one computer system chassis having a limited number of slots for telephony interface cards, such as E1 or T1 circuit cards. Thus, for example, if a computer has 4 PCI slots which can receive 4 E1 cards, and each E1 card can support 4 trunks, then the SS7 gateway system can only support 16 trunks, and cannot be easily extended to handle additional trunks. In addition, each IVR system may require a separate trunk. Thus, using conventional systems, expensive multiple computer systems hosting SS7 gateways may be needed to provide an adequate number of trunks to support the needs of telephony call centers, including IVR systems in a CTI environment.

Further, multiple SS7 links may be needed. SS7 links consist of dedicated, guaranteed bandwidth, full-duplex signaling links. Each SS7 link is expensive and subject to a number of monthly operational charges, including physical link charges, connectivity charges, and per-message charges. Because each SS7 link has the capacity to control a much larger number of trunks than the computer system chassis's can support, the SS7 links are inefficiently utilized, resulting in high overall network SS7 costs. Further, another significant shortcoming of conventional SS7 enabled voice call equipment is the need for large numbers of point codes needed for the large number of needed gateways. Every node in an SS7 network requires a unique identifier, called a point code. However, because of the limited number of available point codes, system expansion may be unduly limited.

## Summary of the Invention

The present invention relates to telephony gateways, and in particular, to novel methods and systems for utilizing an Signaling System 7 (SS7) gateway to connect an interactive voice response (IVR) system and the like to a Public Switched Telephone Network (PSTN).

Advantageously, the present invention allows several call processing systems in a CTI system, such as IVR systems, to be connected to the PSTN via one SS7 gateway, thereby providing efficient control of many voice trunks with one SS7 link. The SS7 gateway receives the SS7 signaling from a PSTN switch over a first trunk, while the voice data is transmitted from the PSTN switch to one or more IVR systems over one or more TCP trunk lines. The SS7 gateway communicates with the IVR systems over a local area network, wide area network or the Internet using an SS7 gateway-to-IVR data signaling format.

In one embodiment of the present invention, several SS7 gateways may be geographically distributed, for example, in different countries, while several IVR systems are co-located in one geographical area. The distributed SS7 gateways are connected to the corresponding IVR systems via the Internet, and signaling between the SS7

gateways and the corresponding IVR system is performed utilizing TCP/IP. The IVR systems are connected to the PSTN via voice trunks. The novel arrangement allows for each maintenance and management of the co-located IVR systems, while allowing communications from around the world to be efficiently routed to the remotely located IVR systems.

In addition, multiple IVR systems may be used to provide redundancy. In one embodiment, two or more IVR systems are connected a PSTN switch using the same voice TCP trunk line or lines. If, for example, a first IVR system is a primary IVR system, the SS7 gateway would direct the call setup messaging and the like to the first IVR system. If the first IVR system fails, the SS7 gateway would direct the call setup messaging and related messaging to the second IVR system, which acts as a backup system, so that the second IVR system handles the calls and communicates voice data with the PSTN switch over the TCP trunk line.

One embodiment of a call processing protocol used in a conjunction with a gateway for connecting a PSTN switch and a call processing system, such as an interactive voice response (IVR) system, in a computer telephony integration (CTI) network in accordance with a common channel signaling method will now be described. For an inbound call, first, if an initial address message (IAM) signal is received from the switch, the SS7 gateway sends an address complete message (ACM) signal to the switch and a call notify (NFY_CALL) message, using a format described below, to the designated IVR system to request a call setup. An inbound call received from the switch is connected to the IVR system if a call confirmation (CFM_CALL) message of a predetermined format is received from the IVR system. An answer message (ANM) is then sent by the gateway to the switch.

If the IVR systems wants to cancel a call, the IVR system sends a call cancellation request (REQ_CANCEL) message to the gateway using the message format described below. In response, the gateway transfers a release (REL) message to the switch. In response to receiving the release signal REL, the switch releases the call and sends a release complete (RSC) message to the gateway. The gateway then sends a cancellation complete (RSP_CANCEL) message to the IVR systems and the connection between the switch and the IVR system is released.

For an outbound call, the procedure is as follows. The gateway sends an IAM signal to the switch if a call request (REQ_CALL) message utilizing the message format described below is received from the IVR system. An outbound call is transferred from the IVR system to the switch if the answer message (ANM) signal is received by the gateway from the switch. Upon receiving an address confirmation (ACM) signal from the switch, the gateway sends a call response (RSP_CALL) message of the message format described below.

Conventional SS7 gateway systems communicate with IVR systems utilizing message formats that are the same or substantially similar to that used as part of the SS7 network protocol. For example, conventional SS7 messaging from an SS7 gateway to an IVR system may include all the SS7 signaling information, with the exception of certain status information. Thus, these conventional messaging formats are limited, requiring significant processing overhead on the part of call processing systems, such as IVR systems.

This is in contrast with one embodiment of the present invention which utilizes a novel messaging process between SS7 gateways and IVR systems, which, in one embodiment, limits the information sent by a SS7 gateway to

an IVR system to information related to call setup, management, and tear down. Thus, the burden of handling SS7 network messaging is handled by an intelligent SS7 gateway, and the IVR system is offloaded from handling such SS7 network messaging. One embodiment of the novel SS7 gateway-to-IVR communication process includes the following message types: NFY_CALL, CFM_CALL, REQ_CANCEL, RSP_CANCEL, REQ_CALL. Because the SS7 Gateway handles the interface with the SS7 network, the IVR is able to receive and transmit information using less complex messaging formats, reducing the burden on IVR systems connected to the SS7 gateway.

## Brief Description of the Drawings

Figure 1 is a block diagram of a communications network which may be used in accordance with one embodiment of the present invention;

Figure 2 is an architectural diagram illustrating an embodiment of the SS7 gateway illustrated in Figure 1;

Figure 3 is process diagram illustrating call processing utilizing a communications network;

Figure 4 is a diagram of an example message data format used to communicate messages between an SS7 gateway and an IVR system;

Figures 5A-B are flow diagrams illustrating two procedures for processing an inbound call utilizing the data format illustrated in Figure 4.; and

Figures 6A-B are flow diagrams illustrating two procedures for processing an outbound call utilizing the data format illustrated in Figure 4.

## Detailed Description of Preferred Embodiments

In the following description, reference is made to the accompanying drawings, which form a part hereof, and which show, by way of illustration, specific embodiments or processes in which the invention may be practiced. Numerous specific details are set forth in order to provide a thorough understanding of the present invention. The present invention, however, may be practiced without the specific details or with certain alternative equivalent components and methods to those described herein. In other instances, well-known methods and components have not been described in detail so as not to unnecessarily obscure aspects of the present invention.

The present invention provides for the more efficient use of SS7 gateways and communication trunks. By having voice and SS7 messaging transmitted over different trunks, the present invention allows several IVR systems to be connected to a PSTN switch via one SS7 gateway, thereby providing efficient control of many voice trunks with one SS7 link. The SS7 gateway receives SS7 signaling from a PSTN switch over a first trunk, while the voice data is transmitted from the PSTN switch to one or more IVR systems over one or more TCP voice trunks. The SS7 gateway communicates with the IVR systems over a local area network, wide area network or the Internet using an SS7 gateway-to-IVR data signaling format. Thus, for example, utilizing the systems and methods described below, one SS7

gateway hosted by a typical desktop computer or server can handle the SS7 messaging for many more than the 16 trunks handled by many conventional systems.

Figure 1 is a diagram of an example communications network which can be used in accordance with one embodiment of the present invention. Referring to Figure 1, a PSTN switch 102 and an SS7 gateway 104 are connected by a link, such as an E1 or T1 link. Each IVR system 106A, 106B is connected to the PSTN switch 102 via a corresponding TCP trunk line 108, 110. There may be additional TCP lines between the PSTN switch 102 and an IVR system in order to carry additional trunks. The SS7 gateway 104 and interactive voice response (IVR) systems 106A and 106B are connected by Transmission Control Protocol/Internet Protocol (TCP/IP) through a network, such as a local area network (LAN) or a wide area network (WAN) used as part of the Internet or an intranet. The SS7 gateway may be hosted on a first computer system, such as a server, and the IVR systems 106A, 106B are hosted on separate computer systems.

The PSTN switch 102 provides signaling in compliance with the SS7 standard. A communication channel with the SS7 gateway 104 is defined by a trunk and a circuit. While in this example, there are two IVR systems, fewer or additional IVR systems may be used. Signaling between the PSTN switch 102 and the SS7 gateway 104 is in accordance with the SS7 standard and is processed accordingly. Messages are defined and exchanged between the SS7 gateway 104 and the IVR systems 106A and 106B using TCP/IP in accordance with a transaction format described below. Voice data is transferred between the PSTN switch 102 and the IVR systems 106A, 106B via the corresponding TCP trunk lines.

Advantageously, the IVR systems 106A, 106B may act as redundant IVR systems. In this embodiment, both IVR systems 106A, 106B are connected to the same voice TCP trunk or trunks. If the IVR system 106A is to be the primary or active IVR system and the IVR system 106B is to be the backup or standby IVR system, then during the registration process the IVR system 106A is registered as "active" and IVR system 106B is registered as "standby." Thus, for example, if IVR system 106A is active, the SS7 gateway would direct call messaging, such as call setup messaging and the like, to the IVR system 106A. If, however, the SS7 gateway detects or is notified that IVR system 106A failed, the SS7 gateway directs the call messaging to IVR system 106B so that IVR system 106B can handle the calls and communicate voice data with the PSTN switch 102 over the TCP trunk line. Thus, IVR service is substantially uninterrupted even when one IVR system is not available.

Figure 2 is a block diagram of an SS7 gateway which may be used in accordance with one embodiment of the present invention. Referring to Figure 2, the SS7 gateway 104 includes several SS7 modules mounted on an operating system, such as the internet telephony operating system (iTOS) 200 described in the co-pending Internet Telephony Operating System application, filed December 28, 2000, and incorporated herein by reference in its entirety, or may be mounted on other operating systems, such as Linux, Microsoft Windows 2000, Sun OS, Unix, or the like. In the illustrated embodiment, the SS7 modules include an SS7 call controller 210 for controlling an SS7 call, an SS7 maintenance controller 220, an intelligent switch (IS) call interface 230, a message storage controller (MSC) 240 and a billing system (BS) 250.

The SS7 call controller 210 supports the SS7 protocol stack and levels, and includes a signaling connection control part (SCCP) 211, a transaction capabilities application part (TCAP) 212, an ISDN user part (ISUP) 213, and a telephone user part (TUP) 214. The SCCP 211 is used to route a non-circuit signal between arbitrary signaling end points and includes a control function for controlling message flow and sequence. For example, the SCCP 211 provides end-to-end addressing and routing for SS7 Level 4 protocols, such as TCAP. The TCAP 212 provides the transaction capabilities carried out by non-circuit based messages used to access remote databases and invoke remote feature capabilities in network elements. For example, TCAP is used for 800, 888, and 900 number translation. TCAP further provides the mechanism to carry the queries and responses from switch to switch. The TCAP 212 consists of a transaction part and a component part. The transaction part controls start and termination of transaction which is the operation unit between a switch and a service control office. The component part stipulates basic operations of the switch and service control office.

The ISUP 213 transmits and receives a call control signal in accordance with a predetermined signal format. ISUP is a circuit-based protocol used to establish and maintain connections for data and voice calls as well as performing disconnects in the PSTN. ISUP sets up and tears down the circuit used to connect PSTN voice and data subscribers, including ISDN, analog, and ISDN-to-analog users. The TUP 214 is a link-to-link signaling system used to connect telephone or speech calls, as well as facsimile calls. The IS Call Interface 230 is used to process communications and messaging with the IVR systems. The messaging format and processes are discussed below in greater detail.

Figure 3 is process diagram illustrating call processing utilizing a communications network. An IS Call Interface 302, a Client A 310 and a Client B 320 are connected by TCP on a network, such as a LAN, WAN, intranet or Internet. Client A 310 and Client B 320, may be, by way of example, IVR systems, such as those illustrated in Figure 1. As illustrated in Figure 3, as the Client A 310 is registered in the IS Call Interface 302 by a port socket 7788, and a registration thread 304, which provides the IP, alias address, and trunk information for the first and second IVR. The registration thread 304 is generated as a standard ISUP message which is then converted to a TCP/IP message. In addition, the registration thread 304 generates a trunk control process (Trunk 1 Control) 306 generated for Client A 310 and a trunk control process (Trunk 2 Control) 308 is generated for Client B 320. When an IVR system starts up, it sends a registration packet to the IS call controller 302. The registration packet includes the IVR IP and alias address, and the number of trunks available.

Calls are controlled by a corresponding direct or exclusive TCP link between the IS Call Interface 302 and the Clients A and B 310 and 320. Because Client 310 and 320 each have a direct TCP link, Client 310 and Client 320 use different sockets to communicate with the SS7 gateway 104, which acts as a server for each client.

Referring to Figure 3, Trunk 1 is allocated to the Client A 310 and Trunk 2 is allocated to the Client B 320 so that signaling for Trunk 1 is established between the Trunk 1 control process 306 and the Client A 310, and signaling for Trunk 2 is established between the Trunk 2 Control process 308 and the Client B 320. Voice data is

communicated between a switch 330 and Client A 310 and Client B 320 via corresponding trunks, Trunk 1, Trunk 2. The switch 330 may be, for example a central office or telco switch.

Figure 4 illustrates a novel data format used to generalize ISUP messages for transactions between an SS7 gateway and an IVR system. This data novel data format advantageously allows the ISUP messages used in SS7 network to be represented in a manner which may be efficiently used by the clients. However, the present invention is not limited to using the data format illustrated in Figure 4, and other formats may be used as well.

As illustrated in Figure 4, a transaction format of the present invention includes fields to specify source, type of operation, operation status, identifier, originating address, destination address, circuit number, trunk number and caller information. As illustrated in Table 1 below, the source may be an SS7 gateway or an IVR system having a specific number. For example, if the source is an IVR system and there are three different possible IVR systems, the field may be used indicate whether the source is IVR system No. 1, IVR system No. 2, or IVR system No. 3.

As illustrated in Table 2 below, the operation type may be a setup request, a release request, a registration request, a de-registration request and an acknowledgement. As illustrated in Table 3 below, the status may be "acknowledgement" or "request." The identifier field is used to specify the packet ID. The originating address field is used to specify the point code of the source, and the destination address is used to specify the point code of the destination. The circuit number field is used to specify the circuit or channel number of the E1 or T1 link for a given trunk, where there may be, for example, 24 circuits for each trunk. The trunk number field is used to specify the trunk number. The caller information field is used to indicate the type of caller device being used, such as cellular phone, facsimile machine, analog phone, and the like.

| SOURCE FIELD |
|---|
| SS7 Gateway |
| IVR System Number |

Table 1

| OPERATION TYPE FIELD |
|---|
| Setup Request |
| Release Request |
| Registration Request |
| De-registration Request |
| Acknowledgement |

Table 2

| STATUS FIELD |
| --- |
| Request |
| Acknowledgement |

Table 3

If the SS7 gateway 104 receives an Initial Address Message (IAM) signal, including the complete called number, from the PSTN switch 102, a setup notification message (NFY_CALL) is transferred via the IS call interface 230 from the SS7 gateway ISUP 213 to the appropriate IVR system 106A or 106B, where IVR system 106A is designated as IVR #1, and IVR system 106B is designated as IVR #2. This example assumes the setup request notification is being sent to IVR system 106A. Utilizing the messaging format illustrated in Figure 4, the source field is set to "SS7 gateway" and the operation type field is set to "setup request." The setup notification message format includes information containing identifier, originating address, destination address, circuit number, trunk number, and caller information. After transmitting the setup notification message, the SS7 gateway sends an alerting message to the PSTN switch 102 in the form of an Address Completion Message (ACM). In response to the setup notification message, the IVR system 106A sends a confirmation or acknowledgement message CFM_CALL to the SS7 gateway 104. Utilizing the message format illustrated in Figure 4, the source field is set to "IVR #1," the operation type field is set to "setup request," and the status field is set to "acknowledgment." The SS7 gateway 104 then sends an Answer Message (ANM) to the PSTN switch 102.

In order to initiate a connection release, a release request message REQ_CANCEL is transferred from the SS7 gateway ISUP 213 via the IS Call Interface 230 to the appropriate IVR system 106A or 106B. In this format, the source is set to "SS7 gateway" and the operation type is set to "release request", and the status is set to "request." Utilizing the format illustrated in Figure 4, this message includes information containing identifier, originating address, destination address, circuit number, trunk number, and caller information. The source is set to "SS7 gateway," and the operation type is set to the operation type is set to "release request." Once the IVR system receives the release request message, it responds by sending a release confirmation message RSP_CANCEL to the SS7 gateway 104. The source is set to "IVR [#]," where [#] represents the IVR number or identifier, the operation type is set to "release request" and the status is set to "acknowledgement."

If an IVR system is initiating an outbound call, a setup request message (REQ_CALL) is sent by the initiating IVR system 106A or 106B to the SS7 gateway 104. Utilizing the message format illustrated in Figure 4, in the setup request message format, the source is set to "IVR [#]", the operation type field is set to "setup request", and the status field is set to "request." The other fields contain the corresponding identifier or caller ID, originating address, destination address, circuit number, trunk number, and caller information. The SS7 gateway then sends an IAM message to the PSTN switch 102, which responds with an ANM message and an ACM message. In a response message originated after the SS7 gateway 104 sets up a call, the source is set to "SS7 gateway", the operation type

is set to "setup request," and the status is set to "acknowledgment." The other message fields contain the corresponding identifier or caller ID, originating address, destination address, circuit number, trunk number, and caller information. In a response message transferred from the IVR systems 106A and 106B to the SS7 gateway 104 after a call setup, the source is set to "IVR [#]", the operation type is set to "setup request", and the status is set to "acknowledgement." The other fields contain the corresponding identifier or caller ID, originating address, destination address, circuit number, trunk number, and caller information.

When the IVR initiates a release, a release request message is sent by the IVR system 106A or 106B to the SS7 gateway 104. Utilizing the messaging format illustrated in Figure 4, the source is set to "IVR [#]", the operation type is set to "release request," and the status is set to "request." The other fields contain the corresponding identifier or caller ID, originating address, destination address, circuit number, trunk number, and caller information. In a release confirmation message transferred from the SS7 gateway 104 to the originating IVR system 106A or 106B, the source is set to "SS7 gateway", and the operation type is set to "release request", and the status is set to "acknowledgement." The other fields contain the corresponding identifier or caller ID, originating address, destination address, circuit number, trunk number, and caller information.

A call bridging process, where an IVR system bridges an inbound call and an outbound call, will now be described. Call bridging may be performed, for example, when a call is being placed by an analog phone. The IVR system takes the call from the analog phone, receives the long digit information, and then places the call on the digital network. First, an IVR system 106A or 106B requests a call setup to the SS7 gateway 104. Utilizing the message format illustrated in Figure 4, the source is set to "IVR [#]", the operation type is set to "setup request", and the status is set to "request." The other fields contain the corresponding identifier or caller ID, originating address, destination address, circuit number, trunk number, and caller information. In response, the SS7 gateway sends an acknowledgment or confirmation to the initiating IVR system. The source is set to "SS7 gateway", operation type is set to "setup request", and status is set to "acknowledgment." The other fields contain the corresponding identifier or caller ID, originating address, destination address, circuit number, trunk number, and caller information.

A registration request message, a de-registration request message and an acknowledgement message may be similarly be generated and transmitted utilizing the message format illustrated in Figure 4, with the operation type field appropriately set.

Figure 5A is a flow diagram illustrating an procedure of processing an inbound call in accordance with another embodiment of the present invention. An inbound call is a call transferred from a PSTN switch 102 to the designated IVR system 106A or 106B via the SS7 gateway 104. If the SS7 gateway 104 received an IAM signal from the PSTN switch 102, the SS7 gateway 104 sends an address complete message (ACM) signal to the PSTN switch 102 and then sends a call notification (NFY_CALL) message to the designated IVR system 106A or 106B. Upon receipt of the NFY_CALL message, the IVR system sends a call confirmation (CFM_CALL) message to the SS7 gateway 104, with the source set to "IVR [#]," the status is set to "acknowledge," and the other message fields retain the same values as were in the NFY_CALL notification message. After receiving the CFM_CALL message, the SS7

gateway 104 sends an answer message (ANM) signal to the PSTN switch 102. If the PSTN switch 102 and the IVR systems 106A and 106B are connected through the above-described procedure, a communication path is established between the originating address and the destination address, thereby allowing the IVR system to offer the IVR services.

Figure 5B is a flow diagram illustrating another example procedure of processing an inbound call in accordance with another embodiment of the present invention. In this example, the SS7 does not wait for confirmation messages from the IVR before sending the ACM or ANM messages to the PSTN switch 102. This speeds up communication between the SS7 gateway and the PSTN switch at the risk of eliminating certain sequential handshaking checks. Referring to Figure 5B, an inbound call is a call transferred from a PSTN switch 102 to a designated IVR system 106A or 106B via the SS7 gateway 104. If the SS7 gateway 104 receives an IAM signal from the PSTN switch 102, the SS7 gateway 104 sends an address complete message (ACM) signal to the PSTN switch 102 and then sends a call notification (NFY_CALL) message to appropriate one of the IVR systems 106A and 106B. After the SS7 gateway 104 sends the NFY_CALL message to the IVR, the SS7 gateway 104 sends an answer message (ANM) signal to the PSTN switch 102. If the designated IVR system 106A and 106B receives the NFY_CALL message, the IVR system sends a call confirmation (CFM_CALL) message to the SS7 gateway 104, with the source set to "IVR [#]," the status is set to "acknowledge," and the other message fields retain the same values as were in the NFY_CALL notification message.

If an IVR system 106A or 106B sends a call cancellation request (REQ_CANCEL) message to the SS7 gateway 104, the SS7 gateway 104 transfers a release (REL) signal to the PSTN switch 102 and transfers a cancellation complete (RSP_CANCEL) message to the originating IVR system 106A or 106B. If the PSTN switch 102 receives the REL signal, it releases the call and transfers a release complete (RSC) signal to the SS7 gateway 104. Thus, the connection between the PSTN switch 102 and the IVR systems 106A and 106B is released.

Figure 6A is a flow diagram illustrating an example procedure of processing an outbound call in accordance with one embodiment of the present invention. An outbound call is a call transferred from an IP network to a PSTN via the SS7 gateway 104. If a call request (REQ_CALL) message is received from an IVR system 106A or 106B by the SS7 gateway 104, the SS7 gateway 104 sends an IAM signal to the PSTN switch 102, which responds with an ANM signal. Then, if an ACM signal is sent by the PSTN switch 102 to the SS7 gateway 104, the SS7 gateway 104 sends a call response (RSP_CALL) message to the IVR systems 106A and 106B.

If the IVR systems 106A and 106B and the PSTN switch 102 are connected through the above-described procedure, a communication path is established between the originating address and the destination address.

As illustrated in Figure 6A, in order to release a connection, if one of the IVR systems 106A or 106B sends a REQ_CANCEL message to the SS7 gateway 104, the SS7 gateway 104 sends a REL signal to the PSTN switch 102. If the PSTN switch 102 receives the REL signal, it releases the call and transfers the RSC signal to the SS7 gateway 104, which then sends a RSP_CANCEL message to the appropriate IVR system. Thus, the connection between the PSTN switch 102 and the IVR system is released.

Figure 6B is a flow diagram illustrating another example procedure of processing an outbound call in accordance with another embodiment of the present invention. In this example, the ANM message is sent before the ACM message. Referring to Figure 6B, an outbound call is a call transferred from an IP network to a PSTN via the SS7 gateway 104. If a call request (REQ_CALL) message is sent by one of the IVR systems 106A or 106B to the SS7 gateway 104, the SS7 gateway 104 sends an IAM signal to the PSTN switch 102. Then, if an ACM signal is sent from the PSTN switch 102, the SS7 gateway 104 sends a call response (RSP_CALL) message to the IVR systems 106A and 106B. In addition, upon receiving the ACM signal the switch 102 changes the appropriate signal elements and transmits an ANM signal to the SS7 gateway 104

As illustrated in Figure 6B, in order to release a connection, if one of the IVR systems 106A or 106B sends a REQ_CANCEL message to the SS7 gateway 104, the SS7 gateway 104 sends a REL signal to the PSTN switch 102 and transfers the RSP_CANCEL message to the initiating IVR system 106A or 106B. If the PSTN switch 102 receives the REL signal, it releases the call and transfers the RSC signal to the SS7 gateway 104. Thus, the connection between the PSTN switch 102 and the IVR system is released.

Thus, as described above, by having voice and SS7 messaging transmitted over different trunks, the present invention allows several IVR systems to be connected to a PSTN switch via one SS7 gateway, thereby providing efficient control of many trunks with one SS7 link. The SS7 gateway receives the SS7 signaling from the PSTN switch over a first trunk, while the voice data is transmitted from the PSTN switch to one or more IVR systems over one or more TCP trunk lines. The SS7 gateway communicates with the IVR systems over a local area network, wide area network or the Internet, using an SS7 gateway-to-IVR data signaling format. Thus, the SS7 gateway is efficiently utilized.

Although this invention has been described in terms of certain preferred embodiments, other embodiments that are apparent to those of ordinary skill in the art are also within the scope of this invention. Accordingly, the scope of the present invention is intended to be defined only by reference to the appended claims.

WHAT IS CLAIMED IS:

1. A method of interconnecting a Public Switched Telephone Network (PSTN) switch, an SS7 gateway, and a plurality of interactive voice response (IVR) systems, comprising:

connecting a PSTN switch to an SS7 gateway using a first link, wherein the SS7 gateway is hosted on a first computer system;

connecting a first trunk from the PSTN switch to a first IVR system hosted on a second computer system, wherein the first trunk is used to communicate voice data between the PSTN switch and the first IVR system;

connecting a second trunk from the PSTN switch to a second IVR system hosted on a third computer system, wherein the second trunk is used to communicate voice data between the PSTN switch and the second IVR system; and

connecting the first IVR system and the second IVR system to the SS7 gateway using a network, wherein the network is used to communicate SS7 gateway-to-IVR messaging between the SS7 gateway and the first IVR system and the second IVR system.

2. The method as defined in Claim 1, wherein the SS7 gateway communicates with the first IVR system and the second IVR system using TCP/IP.

3. The method as defined in Claim 1, wherein the first trunk is a direct TCP link.

4. The method as defined in Claim 1, wherein the first and second IVR systems are configured as redundant systems.

5. The method as defined in Claim 4, wherein the first IVR system is registered as active and the second IVR system is registered as standby.

6. The method as defined in Claim 1, wherein the SS7 gateway communicates with the first and second IVR systems utilizing a message format including a source field, an operation type field, a status field, an identifier field, an originating address field, a destination address field, a circuit number field, a trunk number field, and a caller information field.

7. The method as defined in Claim 6, wherein the source field is set to "SS7 gateway" when an operation is initiated by the SS7 gateway.

8. The method as defined in Claim 6, wherein the source field is set to "IVR" when an operation is initiated by one of the first and second IVR systems.

9. The method as defined in Claim 6, wherein the operation field is set to one of "setup request," "release request," registration request," and "de-registration request."

10. The method as defined in Claim 6, wherein the status field is set to one of "request" and "acknowledgment."

11. The method as defined in Claim 6, wherein in response to receiving an initial address message (IAM) from the PSTN switch, the SS7 gateway sends a call notify message to one of the first and second IVR

systems, wherein the call message source field is set to "SS7 gateway" and the operation type field is set to "setup request."

12. The method as defined in Claim 6, wherein in response to receiving a request message from one of the first and second IVR systems, wherein the source field is set to "IVR" and the operation type is set to "setup request," the SS7 gateway transmits an initial address message (IAM) to the PSTN switch.

13. A networked interactive voice response (IVR) system, comprising:

a plurality of geographically distributed SS7 gateways, including a first SS7 gateway at a first location connected to a first switch to receive SS7 messaging, and a second SS7 gateway at a second location connected to a second switch to receive SS7 messaging;

a plurality of co-located IVR systems, including a first IVR system and a second IVR system; and

a network connecting the first IVR system to the first SS7 gateway and connecting the second IVR system to the second SS7 gateway, wherein the first SS7 gateway is configured to transmit signaling over the network to the first IVR system, and the second SS7 gateway is configure to transmit signaling over the network to the second IVR system.

14. The method as defined in Claim 13, wherein the first IVR system is connected to a first trunk to receive voice data from a public switched telephone network (PSTN) and the second IVR system is connected to a second trunk to receive voice data from the PSTN.

15. The method as defined in Claim 13, wherein the network is the Internet.

16. The method as defined in Claim 13, wherein the first SS7 gateway is configured to transmit signaling over the network to the first IVR system utilizing SS7 gateway-to-IVR data signaling format.

17. A telephony system comprising:

an SS7 gateway configured to receive SS7 signaling from a switch over a first trunk;

a first interactive voice response (IVR) system connected to the SS7 gateway via a network to receive signaling from the SS7 gateway; and

a first trunk configured to connect the first IVR system to the switch to thereby communicate voice data between the switch and the first IVR system.

18. The telephony system as defined in Claim 17, further comprising:

a second IVR system connected to the SS7 gateway via the network to receive signaling from the SS7 gateway; and

a second trunk configured to connect the second IVR system to the switch to thereby communicate voice data between the switch and the second IVR system.

19. The telephony system as defined in Claim 17, wherein the SS7 gateway is configured to provide signaling to the first IVR system using TCP/IP.

20. The telephony system as defined in Claim 17, wherein the first IVR system provides at least one of voice reproduction of e-mail and Internet phone service.

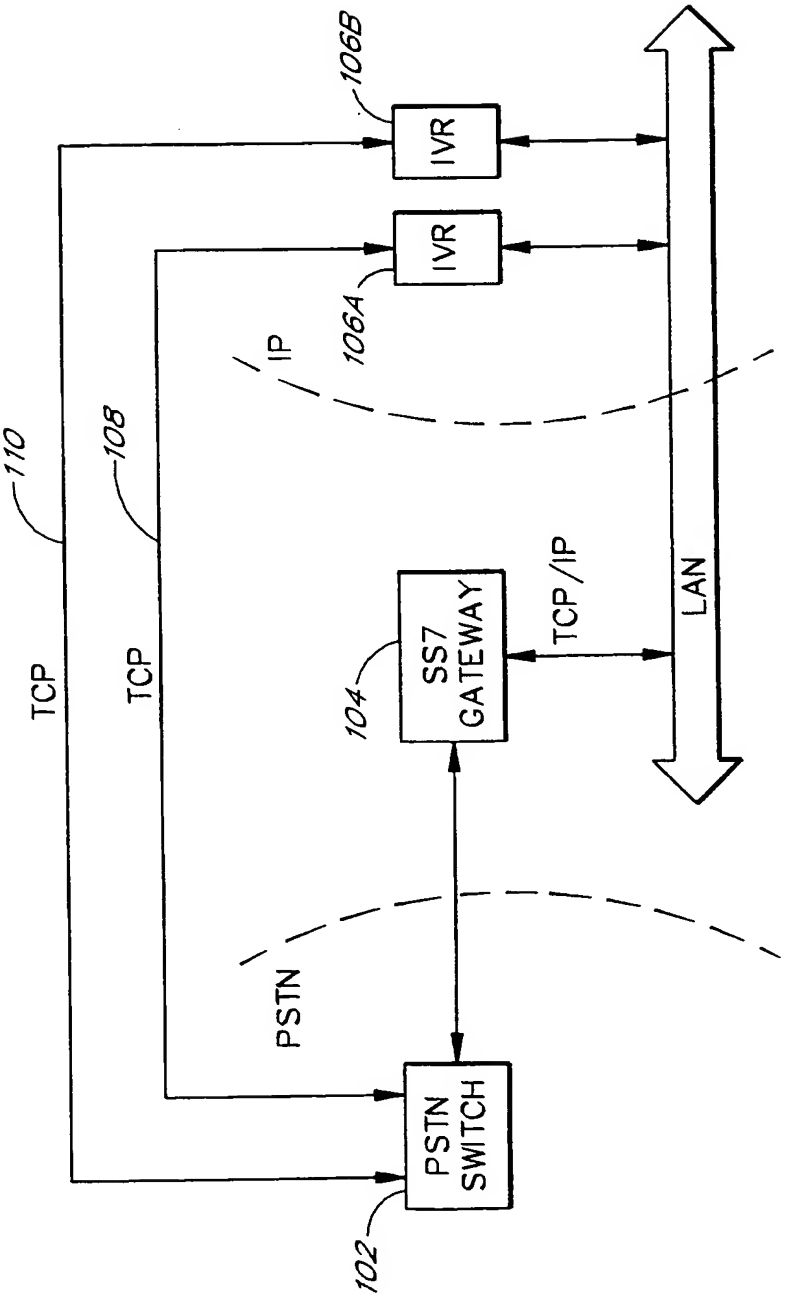
106B
IVR
IVR
106A
IP
110
108
TCP
TCP
104
SS7 GATEWAY
TCP/IP
LAN
PSTN
PSTN SWITCH
102

FIG. 1

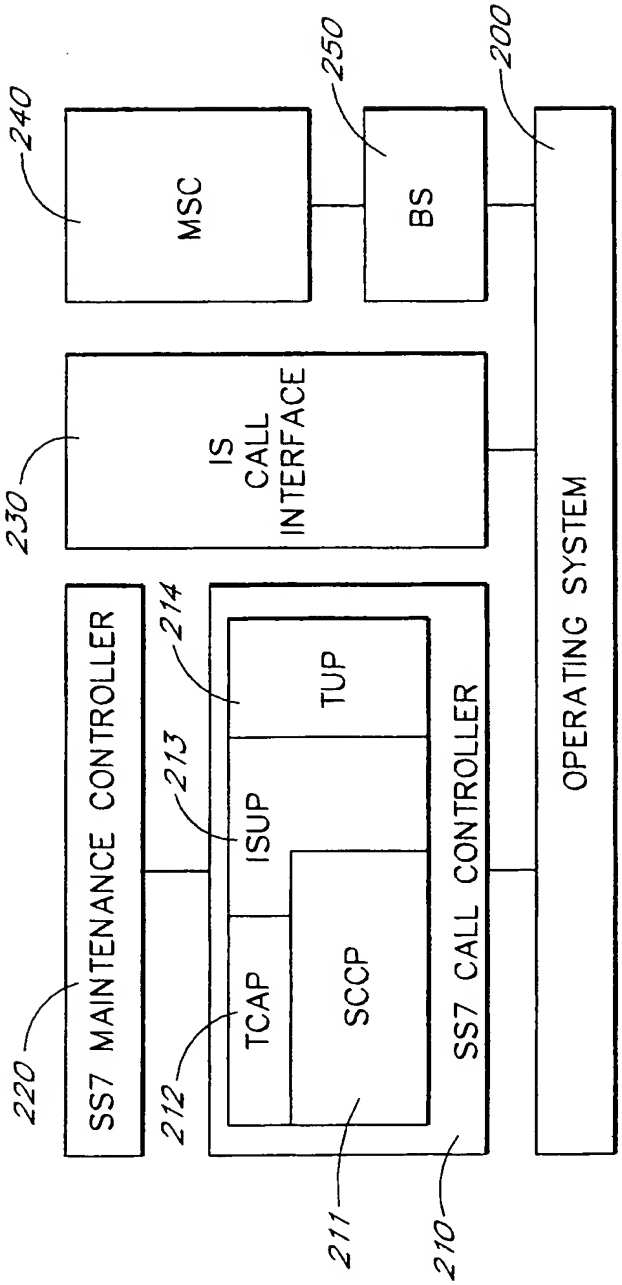
240
MSC
250
BS
200
230
IS
CALL
INTERFACE
OPERATING SYSTEM
214
213
TUP
ISUP
220
SS7 MAINTENANCE CONTROLLER
212
TCAP
SCCP
SS7 CALL CONTROLLER
211
210

FIG. 2

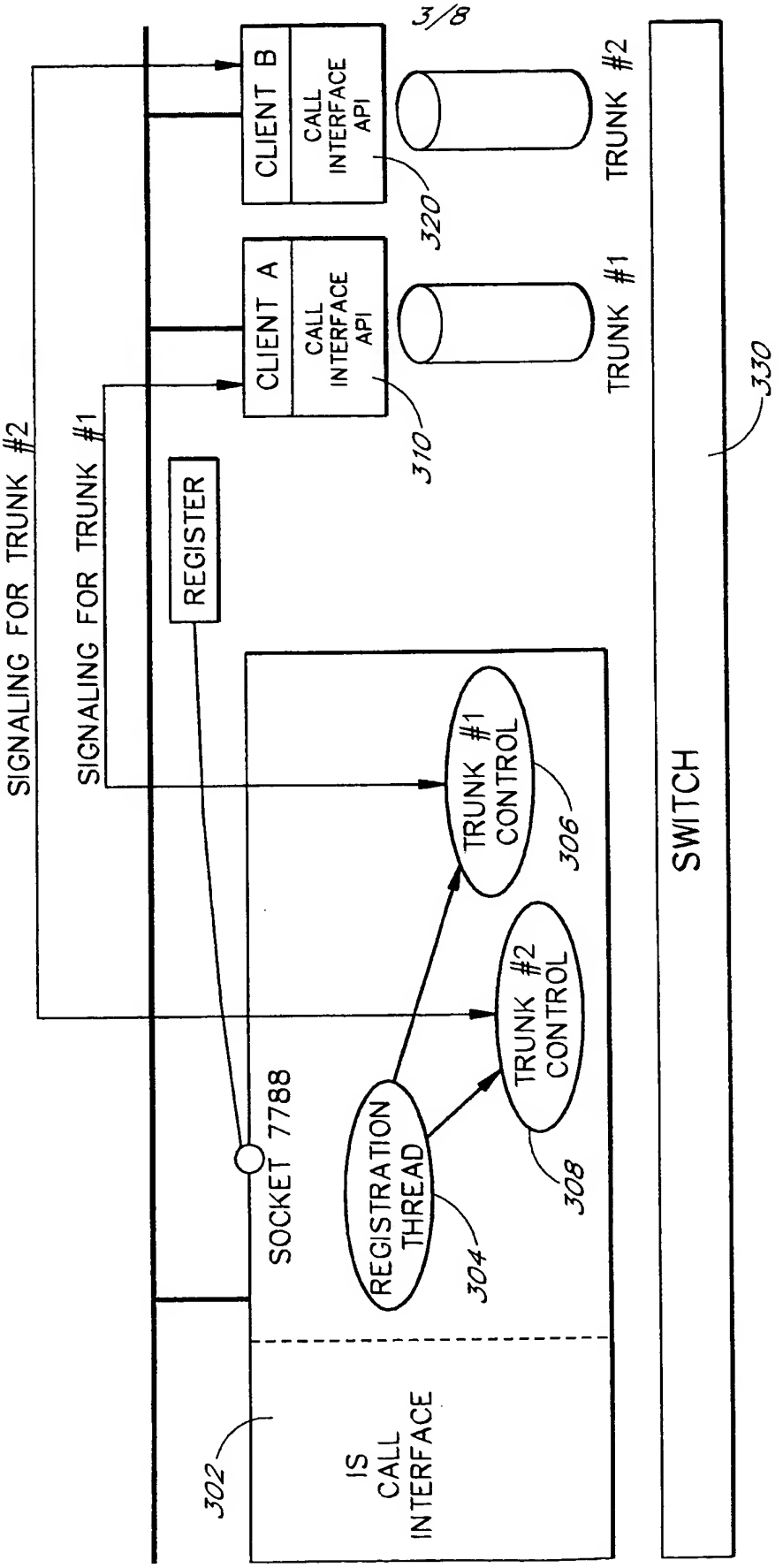
3/8
CLIENT B
CALL INTERFACE API
320
CLIENT A
CALL INTERFACE API
310
TRUNK #2
TRUNK #1
330
SIGNALING FOR TRUNK #2
SIGNALING FOR TRUNK #1
REGISTER
TRUNK #1 CONTROL
306
TRUNK #2 CONTROL
308
SOCKET 7788
REGISTRATION THREAD
304
IS CALL INTERFACE
302
SWITCH

FIG. 3

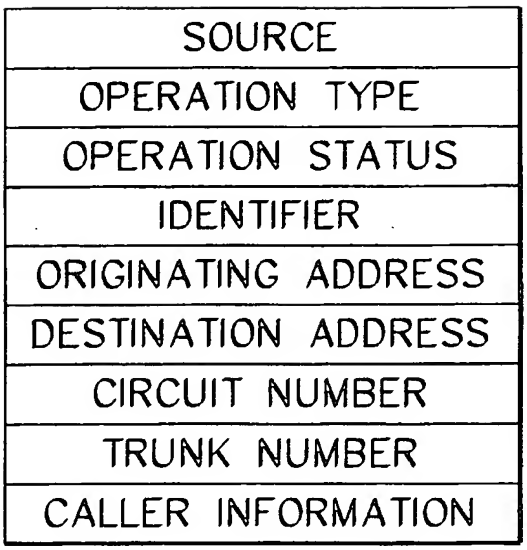
SOURCE
OPERATION TYPE
OPERATION STATUS
IDENTIFIER
ORIGINATING ADDRESS
DESTINATION ADDRESS
CIRCUIT NUMBER
TRUNK NUMBER
CALLER INFORMATION

FIG. 4

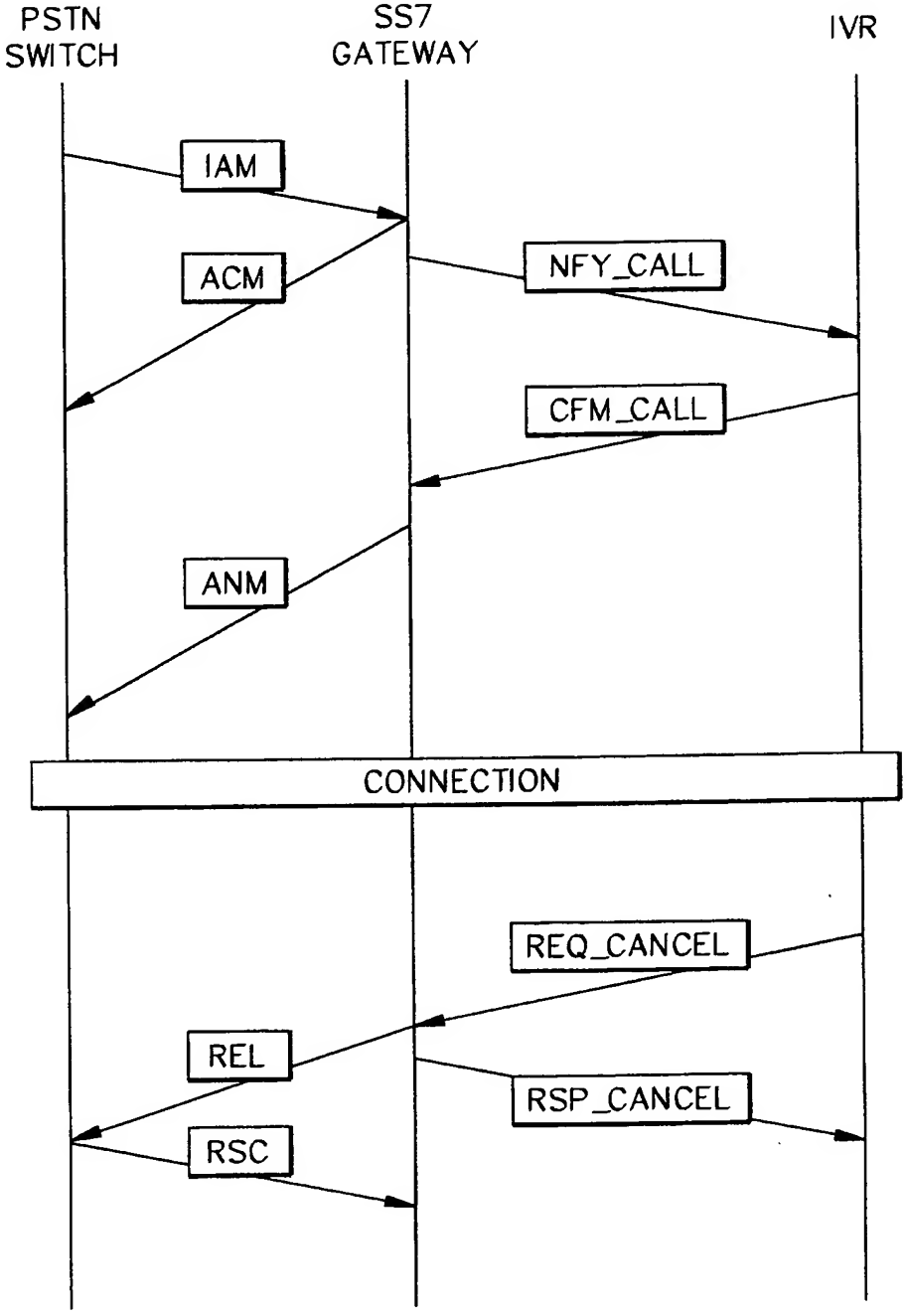
PSTN SWITCH
SS7 GATEWAY
IVR
IAM
ACM
NFY_CALL
CFM_CALL
ANM
CONNECTION
REQ_CANCEL
REL
RSP_CANCEL
RSC

FIG. 5A

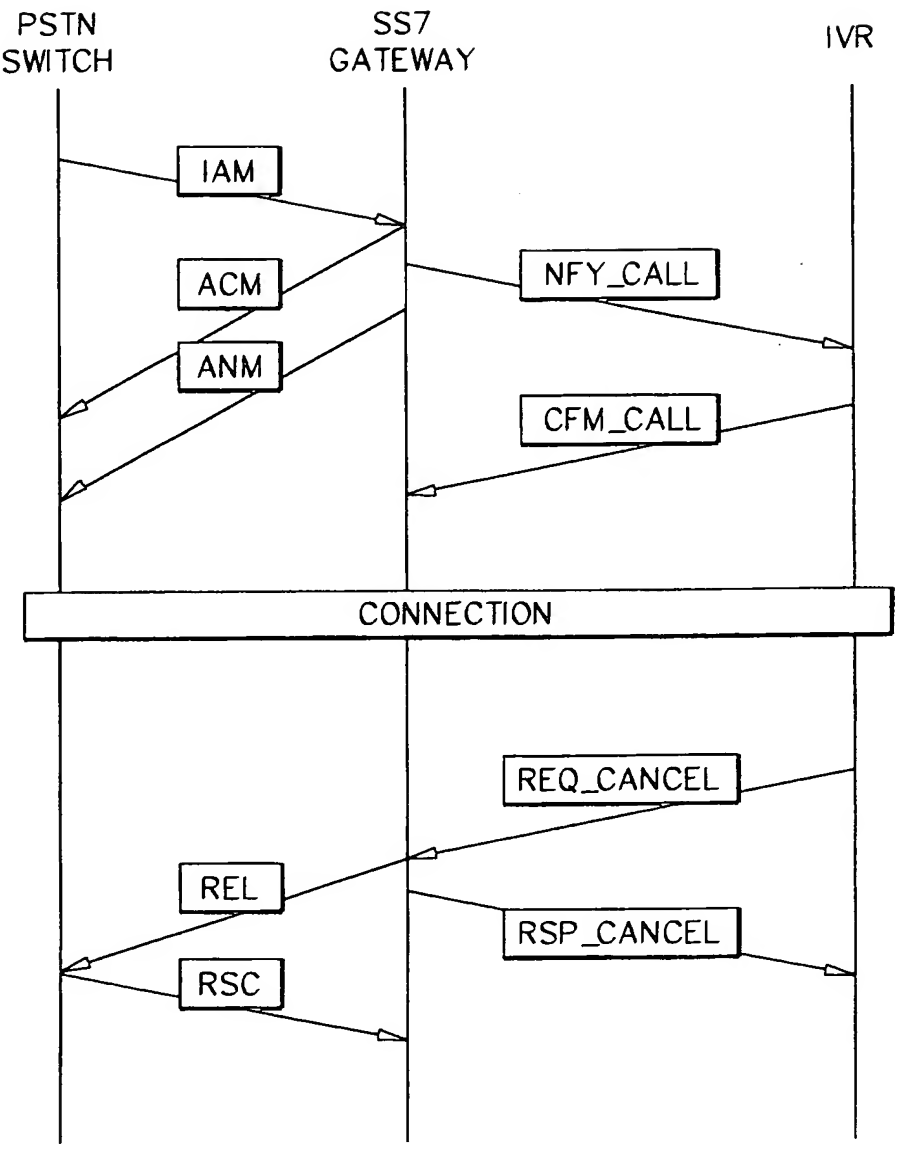
PSTN SWITCH
SS7 GATEWAY
IVR
IAM
ACM
ANM
NFY_CALL
CFM_CALL
CONNECTION
REQ_CANCEL
REL
RSC
RSP_CANCEL

FIG. 5B

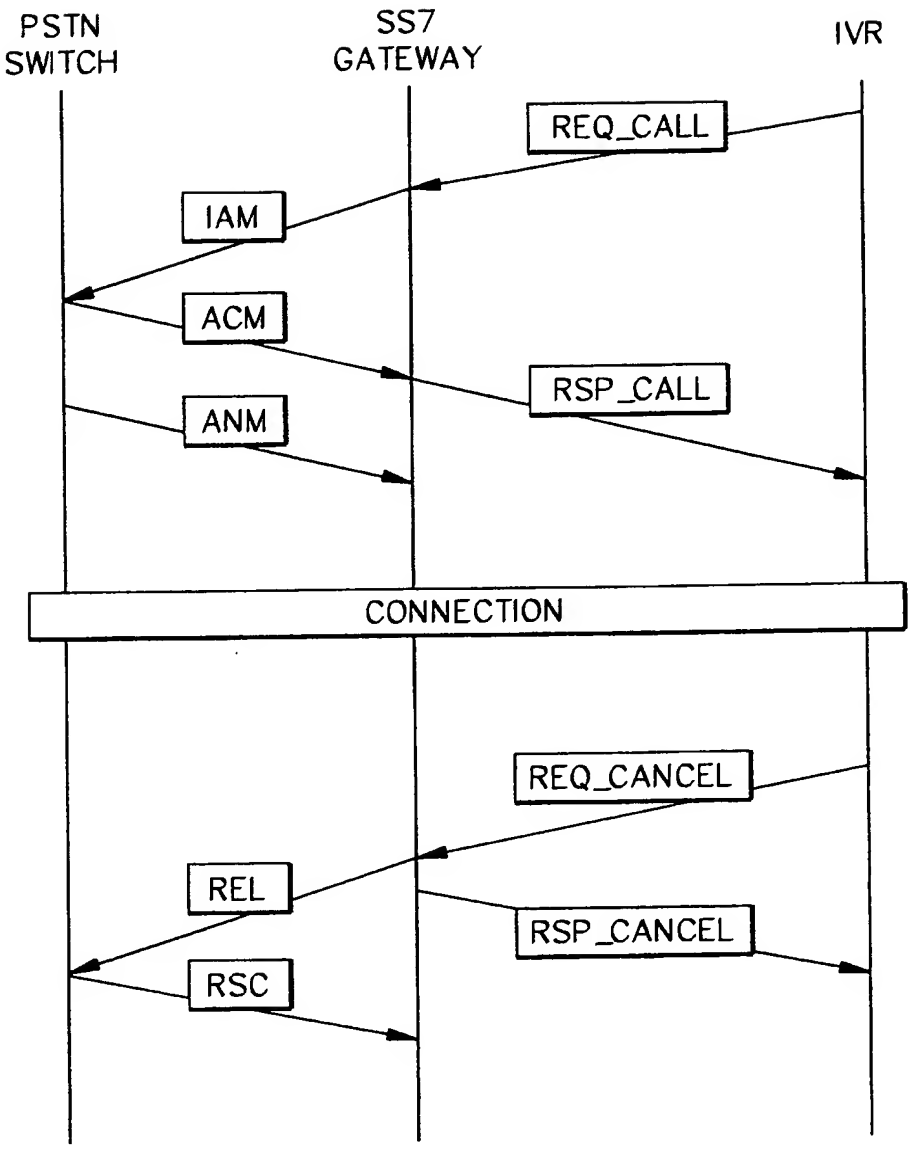
PSTN SWITCH
SS7 GATEWAY
IVR
REQ_CALL
IAM
ACM
RSP_CALL
ANM
CONNECTION
REQ_CANCEL
REL
RSP_CANCEL
RSC

FIG. 6A

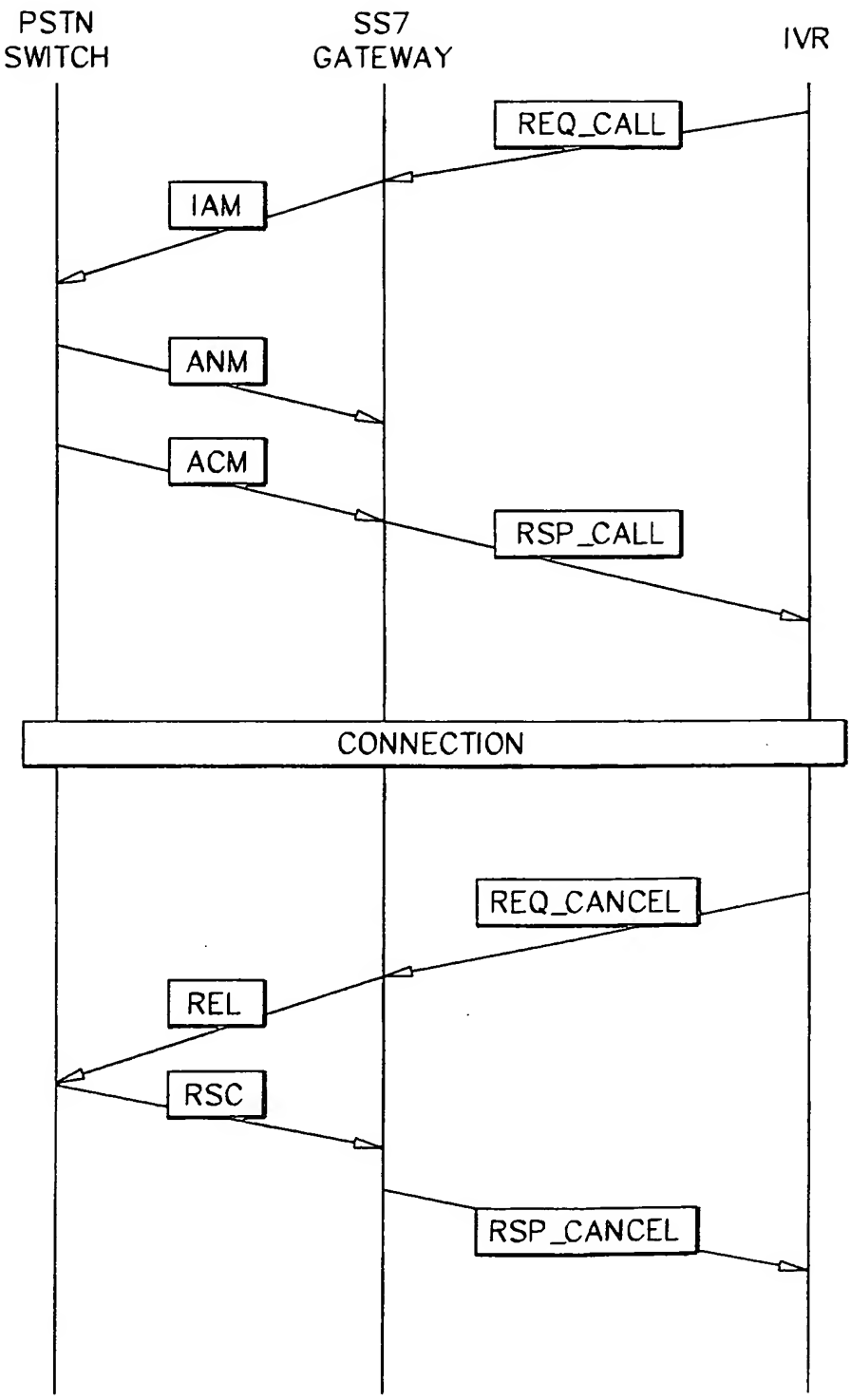
PSTN SWITCH
SS7 GATEWAY
IVR
REQ_CALL
IAM
ANM
ACM
RSP_CALL
CONNECTION
REQ_CANCEL
REL
RSC
RSP_CANCEL

FIG. 6B

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/35618

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H 04M 1/64
US CL : 376/67.1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 376/67.1, 258, 900, 230, 80, 258, 88.1, 88.01, 88.13, 93.07, 93.11, 93.24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

IEEE Communications Magazine

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>---<br>Y | US 5,583,920 A (WHEELER, Jr.) 10 December 1996, Figure 1A, Figure 4, Figure 6, column 6 lines 35-67, column 7 lines 1-30, Column 8 lines 7-42, column 10 lines 49-55, column 11 lines 1-17, column 12 lines 56-67, column 15 lines 45-64, column 17 lines 3-6, column 26-28, and column 29 lines 20-60. | 1-3, 13, 14-16, and 17-20<br>----------<br>6-12 |
| Y | US 6, 084,956 A (TURNER et al.) 04 July 2000, Figures 4-7, column 5 lines 29-67, column 6, column 7 lines 1-32, column 8 lines 38-67, and column 9 lines 1-23 | 6-12 |
| A | US 6,122,364 A (PETRUNKA et al.) 19 September 2000, figure 1, column 3 lines 4-34, and column 6 lines 38-52 | 1-3, 13-20 |

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

| | | | |
|---|---|---|---|
| * | Special categories of cited documents: | "T" | later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
| "A" | document defining the general state of the art which is not considered to be of particular relevance | "X" | document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone |
| "E" | earlier document published on or after the international filing date | "Y" | document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "L" | document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | "&" | document member of the same patent family |
| "O" | document referring to an oral disclosure, use, exhibition or other means | | |
| "P" | document published prior to the international filing date but later than the priority date claimed | | |

| | |
|---|---|
| Date of the actual completion of the international search<br>13 FEBRUARY 2001 | Date of mailing of the international search report<br>18 APR 2001 |
| Name and mailing address of the ISA/US<br>Commissioner of Patents and Trademarks<br>Box PCT<br>Washington, D.C. 20231<br>Facsimile No. (703) 305-3230 | Authorized officer<br>NORA PUTT<br>Telephone No. 703-308-4736 |

Form PCT/ISA/210 (second sheet) (July 1998)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/35618

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 5,878,117 A (MINAKAMI et al.) 02 March 1999, column 4 lines 29-47 and lines 55-65, columns 6-8. | 1-3, 6-20 |
| E | US 6,185,290 B1(SHAFFER et al.) 06 February 2001, figures 2-5, column 27 lines 1-48, column 28 lines 22-41, column 29 lines 9-67, and column 30 lines 1-13. | 1-3, 13-20 |